



Case Study: Liquid Cooling for Data Centers and Stable Control at Scale

How real data center operating experience evolved into OEM liquid cooling systems

OPTO 22
Your Edge in Automation.™

Opto 22

43044 Business Park Drive • Temecula • CA 92590-3614

Phone: 800-321-6786 or 951-695-3000

Pre-sales Engineering is free.

Product Support is free.

www.opto22.com

Form 2452-260319

© 2026 Opto 22. All rights reserved. Dimensions and specifications are subject to change. Brand or product names used herein are trademarks or registered trademarks of their respective companies or organizations.

CASE STUDY: LIQUID COOLING FOR DATA CENTERS AND STABLE CONTROL AT SCALE

How real data center operating experience evolved into OEM liquid cooling systems

AI servers generate far more heat than traditional servers, and many new data centers are turning to liquid cooling to manage it. Liquid transfers heat efficiently, but it also raises the stakes. Pumps, valves, sensors, and long piping loops must operate in sync, and small shifts in system behavior can affect cooling across an entire room of servers.



The team at Nautilus Data Technologies® encountered these challenges well before liquid cooling became a broader industry focus. Years of daily operation revealed what held up under load, what failed, and what a full liquid cooling loop required to remain stable over time.

HOW NAUTILUS DATA TECHNOLOGIES GOT STARTED

Nautilus Data Technologies launched its first liquid-cooled facility in December 2019 in Stockton, California. Built directly on the San Joaquin River, the data center was designed to operate sustainably by using the river as a heat sink, an approach few operators were willing to attempt at the time.

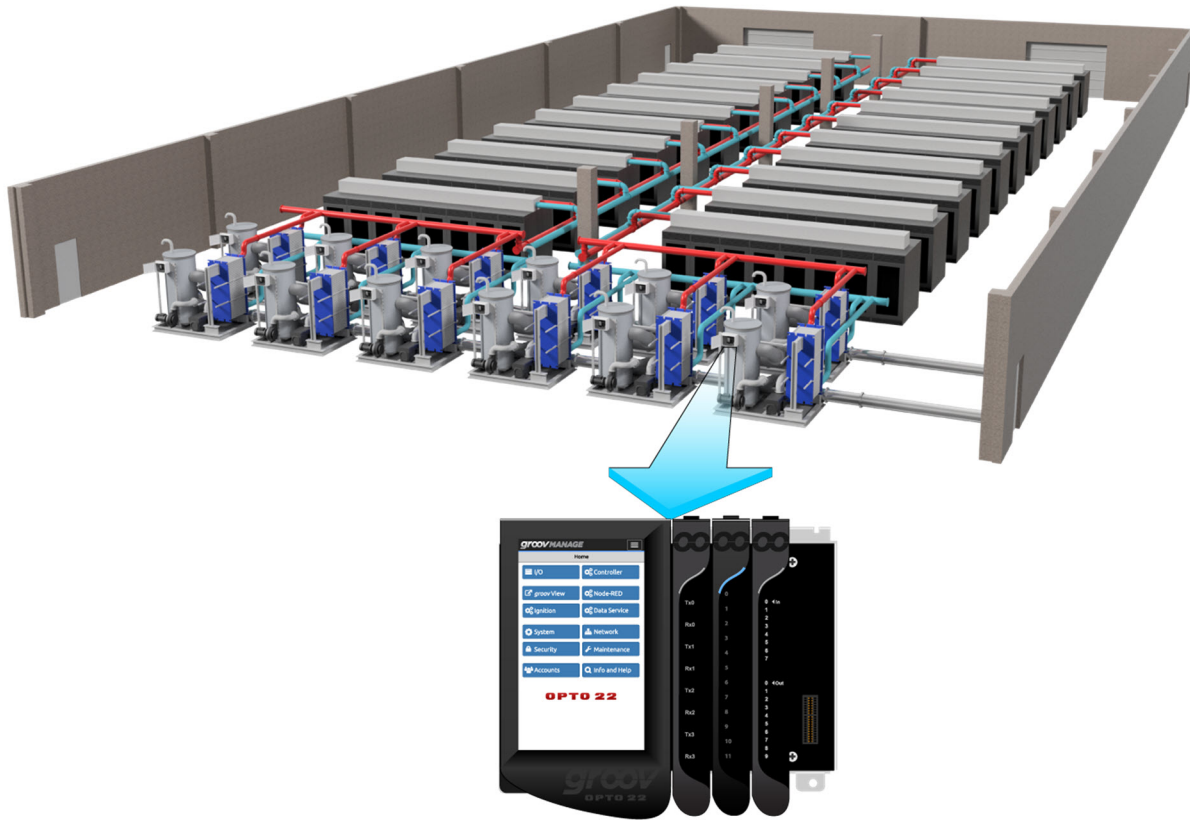
The facility's primary cooling system is an open loop. River water is drawn in, passed through heat exchangers, and returned to the river with minimal temperature change and no environmental impact. The river water never mixes with internal facility systems, eliminating the need for chemical treatment, additives, or discharge management.

By avoiding cooling towers and chillers, Nautilus significantly reduced energy use, water consumption, and



Nautilus Data Technologies' first liquid-cooled data center sits on the San Joaquín River in Stockton, CA.

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale



An example system with cooling skids and liquid-to-chip cooled servers

operational complexity. In 2019, very few data centers were attempting anything comparable.

As Nautilus' Vice President of Product Augustin Roca puts it, "We were developing and operating facility-level liquid cooling years before liquid cooling became mainstream. We were liquid cooled before it was cool."

TURNING OPERATING EXPERIENCE INTO OEM PRODUCTS

Operating the Stockton site gave Nautilus something most cooling manufacturers lacked: years of hands-on experience running a fully liquid-cooled data center. That perspective provided early insight into where the industry was heading.

"We built what we needed to run our own facility, but we knew the market would eventually catch up to those same requirements," says Roca.

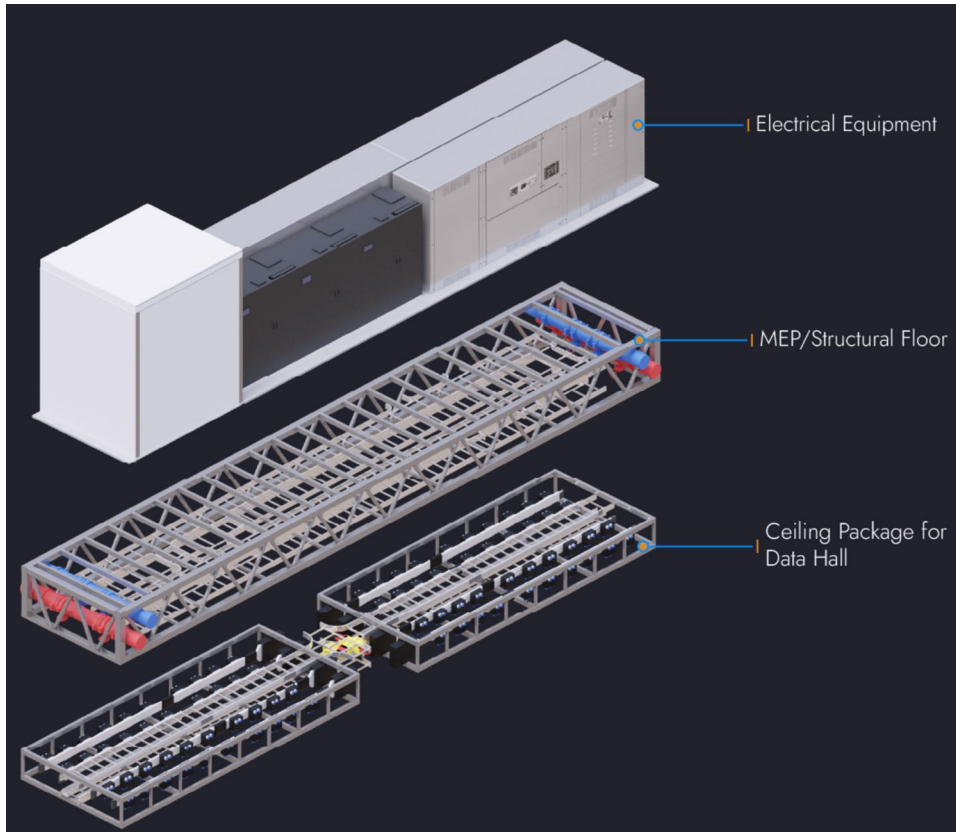
As liquid cooling gained traction in new builds, Nautilus transitioned from operating data centers to developing commercial products, using the Stockton facility as the foundation for its OEM liquid cooling systems.

WHAT OPERATING THEIR OWN FACILITY TAUGHT THEM ABOUT CONTROL

Running a fully liquid-cooled data center at scale gave Nautilus insight most OEMs never gain firsthand. Day-to-day operation revealed how liquid cooling systems respond to real world operating conditions and variations in IT load, how interactions between components propagate through the hydraulic loop, and which failure modes have meaningful operational impact.

"Being an operator gives us a unique edge. We see what holds up under real load, not just what works on paper," says Roca.

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale



A layered design of the floating data center, separating electrical systems, structural framing, and the data hall

Experience drawn from hundreds of thousands of unit hours of operation at the Stockton data center reinforced a simple truth: cooling hardware is only as reliable as the controls running it.

Over those operating hours, the team validated critical behaviors under live IT load. The system maintained stable operation as pressure shifted across varying loads, remained resilient to configuration errors that would challenge less robust systems, and continuously adapted as flow and thermal demand changed.

Maintaining stable pressure, coordinating pumps, handling fault conditions, and giving engineers a clear operational view of the cooling loop all depend on flexible and reliable control logic.

As Nautilus began engineering its next-generation facility scale cooling distribution unit, those lessons shaped every requirement. The team needed a platform that could move data cleanly, adapt as designs evolved, and provide deep visibility without relying on bolt-on systems.

BUILDING SOMETHING NEW

Nautilus facility cooling distribution units were designed from the outset to serve entire data halls across a wide operating range. Earlier generations validated the core architecture, coordinating multiple subsystems while providing operators with a clear, real-time view of system behavior under live IT load. These systems established the



Measuring pump discharge pressure to monitor system performance

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale

foundation for hall-scale liquid cooling, but they were not designed as commercial products.

The EcoCore FCD™ represents the next step in that evolution. It was engineered as a purpose-built, facility scale platform for external deployment, with an emphasis on predictable behavior, operational visibility, and adaptability as system designs and workloads change.

Designed to operate stably across a wide range of flows and pressures, the FCD (Facility Cooling Distribution) remains resilient to configuration changes while providing operators with clear insight into system state without relying on external tooling.

The result is a facility cooling platform that translates years of operating experience into a product designed to be deployed, understood, and trusted by operators outside Nautilus.

TAKING CONTROL OF...CONTROLS

When it came time to select a control platform, the team focused on a short list of priorities: ease of development, clear data visibility, and reliable communication with building management systems and supervisory software.



The Nautilus Data Technologies EcoCore FCD

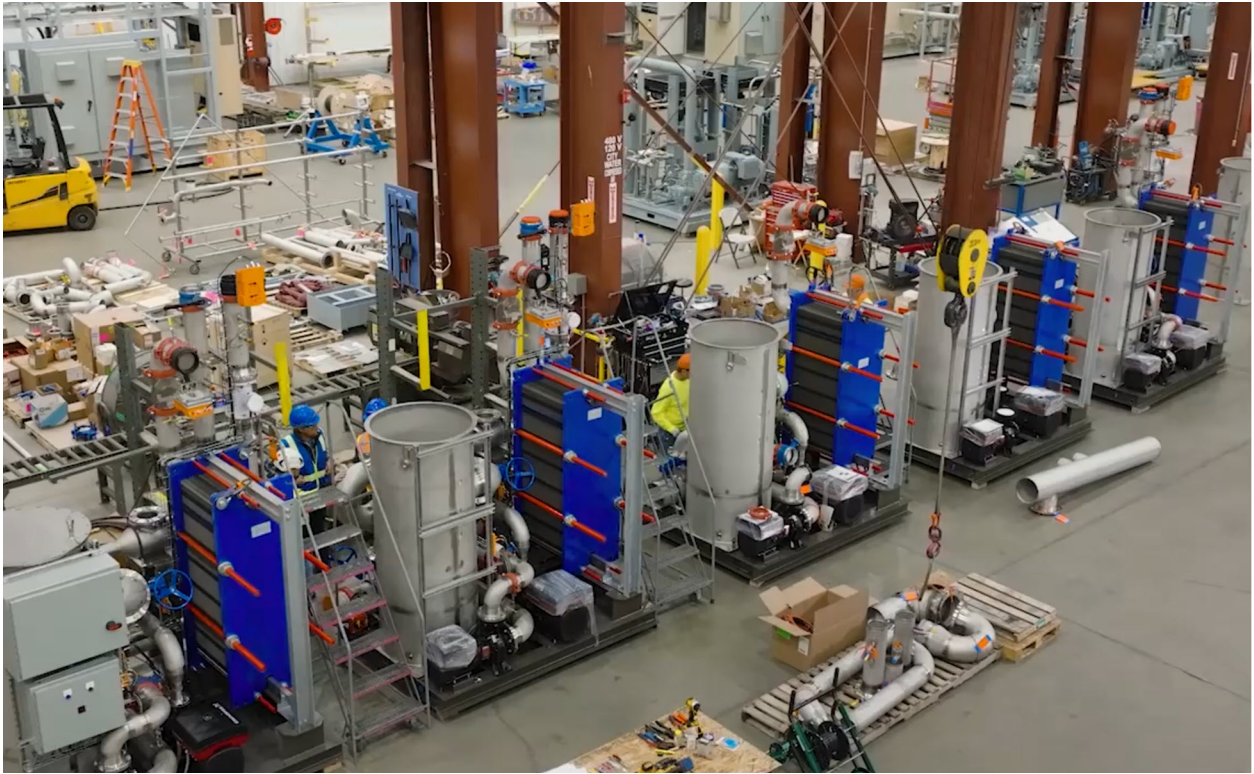
"We needed something that was easy to work with, gave us clean access to the data, and integrated smoothly with the rest of the building," says Roca.

Nautilus had already used Opto 22's *groov EPIC* platform for infrastructure monitoring at the Stockton data center,



Opto 22's *groov EPIC* provides the control solution needed in the EcoCore FCD.

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale



Skid-mounted cooling modules are assembled before installation on the floating data center barge.

where it proved reliable. Familiarity helped, but it was not the deciding factor.

What mattered were *groov* EPIC's built-in tools. [Node-RED](#), [CODESYS](#)®, [Ignition Edge](#)®, and secure REST API access allowed engineers to build and adjust control logic directly, without additional middleware or toolchains. Development could happen quickly and in place, without unnecessary complexity.

Opto 22's manufacturing presence in California also provided a supply chain Nautilus trusted.

INSIDE THE CONTROL ARCHITECTURE

The EcoCore FCD uses two *groov* EPIC processors: a [GRV-EPIC-PR1](#) embedded in the unit and a [GRV-EPIC-PR2](#) serving as the supervisory controller. The PR1 manages real-time control within the FCD, while the PR2 handles higher level coordination and data movement.

Both controllers run CODESYS, an IEC 61131-3 compliant control environment built into every *groov* EPIC processor at no additional cost. Using a standard environment simplified management of pumps, valves, and operating

modes as a unified system. The controllers exchange data over a peer-to-peer OPC UA connection, ensuring reliable communication.

"Working with Opto 22 was key to simplifying the whole system. We needed controls that were highly adaptable and configurable, and that's what we got," says Roca.

"Working with Opto 22 was key to simplifying the whole system. We needed controls that were highly adaptable and configurable, and that's what we got."

- Augustin Roca, Nautilus Data Technologies

The supervisory PR2 also runs Ignition Edge, the embedded version of the Inductive Automation® Ignition® SCADA platform, used for data collection and visualization. Data flows to a central Ignition gateway, where operators use Perspective®, Ignition's web-based HMI, to monitor system status and adjust setpoints remotely.

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale



Rows of servers are cooled by rear-door heat exchangers connected to the barge's river-water cooling system.

The on-unit *groov* EPIC chassis supports a range of I/O modules, including digital inputs for safety systems, serial communications for variable frequency drives, and multifunction modules for flow, pressure, and temperature measurements. All components reside within the *groov* EPIC platform, eliminating the need for external converters or add-ons.

WORKING SIDE-BY-SIDE TO HARDEN THE FIRST FCD

Bringing the first FCD online required refining the controls while the mechanical design was still taking shape. Nautilus needed a partner capable of working closely with its engineers as real-world conditions emerged.

As the system came online, several issues surfaced, including timestamp alignment, logging requirements, and startup sequencing. None interrupted operation, but each required prompt attention. Opto 22's engineering and support teams worked directly with Nautilus to review system behavior, test adjustments, and deliver updates quickly when needed.

One early issue caused the PR1 and PR2 controllers to desynchronize timestamps, affecting event tracking. Nautilus engineers and Opto 22 staff isolated the cause and deployed an update that stabilized clock and logging behavior without taking equipment offline.

"Opto 22 provided a lot of real-time support. They were very responsive and worked closely with us to sort through detailed control issues as they came up," says Roca. "That made a real difference while we were hardening the system."



Heat exchangers transfer heat from the data center cooling loop to river water.

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale



River water cools the Nautilus floating data center.

That collaboration allowed the system to settle into a predictable operating state without slowing deployment or forcing design compromises. With the controls stabilized, the Nautilus team shifted focus from early issue resolution to advancing the product.

WHAT COMES NEXT

Once the first FCD was in operation, it served as a natural extension of the liquid cooling experience Nautilus had already accumulated over years of operating fully liquid-cooled data centers. Rather than acting as a proof point, the FCD carried forward control strategies and operating principles that had already been exercised, refined, and proven in live environments.

“Opto 22 provided a lot of real-time support. They were very responsive and worked closely with us to sort through detailed control issues as they came up.”

- Augustin Roca, Nautilus Data Technologies

As additional customer projects moved forward, Nautilus could point to both long running operational history and a commercially deployed system, and speak from direct experience about reliability, control behavior, and day-to-day operability—the same issues the team had worked through in Stockton and earlier deployments.

As customer requirements evolved, some operators requested specific PLC brands to align with broader facility standards. Nautilus supports those cases when required. Nautilus continues to use *groov* EPIC as a default platform,

carrying forward a control architecture shaped by years of operation and validated through commercial deployment.

Together, Nautilus and Opto 22 have established a control foundation designed to meet the operational demands of modern liquid-cooled data centers.

ABOUT NAUTILUS DATA TECHNOLOGIES

Founded in 2013 by a former Navy Seal, Nautilus Data Technologies set out to engineer the most environmentally innovative and sustainable water-cooled data centers in the industry. Their focus on groundbreaking infrastructure design and cutting-edge technology coupled with their passion for environmental responsibility and sustainability has set new industry benchmarks. Nautilus Data Technologies is changing the way data centers consume natural resources, all while they successfully meet the mission-critical IT needs of their customers.

For more information, visit: <https://nautilusdt.com>

ABOUT OPTO 22

Opto 22 was started in 1974 by a co-inventor of the solid-state relay (SSR), who discovered a way to make SSRs more reliable.

Opto 22 has consistently built products on open standards rather than on proprietary technologies. The company developed the red-white-yellow-black color-coding system for input/output (I/O) modules and the open Optomux® protocol, and pioneered Ethernet-based I/O.

Famous worldwide for its reliable industrial I/O, the company in 2018 introduced *groov* EPIC® (edge programmable industrial controller). EPIC has an open-source Linux® OS and provides connectivity to PLCs, software, and online services, plus data handling and visualization, in addition to real-time control.

groov RIO Ethernet-based edge I/O modules, introduced in 2020, include I/O and IIoT software in a compact industrial package that goes anywhere.

All Opto 22 products are manufactured and supported in the U.S.A. Most solid-state SSRs and I/O modules are guaranteed for life.



The company is especially trusted for its continuing policy of providing free product support, free online training, and free pre-sales engineering assistance.

Case Study: Liquid Cooling for Data Centers and Stable Control at Scale

For more information, visit opto22.com or contact

Opto 22 Pre-Sales Engineering:

Phone: **800-321-6786** (toll-free in the U.S. and Canada)

or **951-695-3000**

Email: systemseng@opto22.com

PAGE 10
Form 2452-260319



OPTO 22 www.opto22.com
43044 Business Park Dr. Temecula, CA 92590-3614

SALES sales@opto22.com
800-321-6786 • 1-951-695-3000

SUPPORT support@opto22.com
800-835-6786 • 1-951-695-3080